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Optimum JPEG Quantization Table Generation for High-Quality Image Compression Using Multiobjective Evolutionary Optimization Based on Decomposition

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Abstract*—Joint Photographic Experts Group (JPEG) standard is a popular compression tool to facilitate decent quality communication of images over the band-limited channel. The compression performance of JPEG coder highly influenced by the nature of quantization technique used to quantize transform coefficients. Indeed, the compression amount and the reconst-ruction quality are strongly controlled by the characteristics of the quantization table. Over the years, several optimization techniques are used to generate optimum quantization table for the JPEG coder. Most of them are relying on to optimize this problem as single objective, but practically this problem is a multi-objective in nature. Hence, this paper aims at optimizing the JPEG quantization table generation problem by utilizing an efficient Multi-objective Evolutionary Algorithm based on Decomposition (MOEA/D) technique. The MOEA/D optimization is proposed because it is less complex and usually offers better petro front as compared to the existing multi-objective optimiz-ation algorithms. Several experiments have been performed to test and compare the compression performance of the quantiz-ation tables generated from the proposed technique. The results validate that the generated optimal quantization tables outperform the default JPEG quantization table and recently proposed TLBO optimization technique.*

Keywords—image compression; JPEG; quantization table; MOEA/D optimization algorithm; compression ratio; PSNR; MSE.

I. INTRODUCTION

Image compression is an important step in the image communication and storage applications. With the emergence of High-definition imaging technology, it now becomes a crucial element to satisfy channel bandwidth limitation and storage space constraints [1]. JPEG is one of the important lossy image compression technique, which is very popular for the image compression applications [2]. The JPEG standard is basically a transform coder which consists of a series of steps in the mapping of the input image to the compressed bit stream [2-5]. The basic functional steps of a baseline JPEG encoder are as follows [1]:

Step 1. Divide the input image into non-overlapping blocks of size 8×8.
Step 2. Apply Forward Discrete Cosine Transform (DCT) to each block independently.
Step 3. Independently quantize each DCT transformed blocks using default quantization table.
Step 4. Apply Run-length and Huffman coding to generate a compressed bitstream.

The baseline JPEG decoder exactly reverts the above steps to decompress the original input image. Functionally, in the JPEG encoding, the quantization is the only step which introduces the loss of information by approximating the DCT coefficients. Indeed, the quantization step entirely controls the compression quality and the compression ratio of JPEG coder. The JPEG suggested a perceptually optimized default quantization table (given in Annex K [2]), for quantizing the DCT coefficient of grayscale images. the default quantization table for luma component suggested by JPEG is shown in Fig. 1.

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Fig. 1. Perceptually optimized default JPEG quantization table given in Annex K for luma component [2].